

Shuttle[®]

Ultrasonic Level Transmitter



User Manual

CE Certificate of conformity

This product complies with the requirements concerning electromagnetic compatibility (EMC) stipulated in Council directive no. 89/336/EEC of 3rd May 1989, altered at directive no. 92/31/EEC, on the approximation of the laws of the Member States relating to electromagnetic compatibility.

We declare that the product complies to the values stipulated in EN 50081-1 and EN 50082-1.

Ex approval of ultrasonic sensor

Shuttle® ultrasonic sensor type 200570 is approved for mounting in explosive atmospheres in zone 2 areas in accordance with EN 50021:1999.

The approval are given by Demko under test no. 99Y.126020X.

Therefore, *Shuttle®* is suited for use in potentially explosive atmospheres (Zone 2, Ex nA II T3), but not in Zone 1 or Zone 0 areas.

Contents

Introduction	5	Basic settings	15
About this manual	5	Selection of measuring unit	16
Main sections	5	Setting of the distance	
Illustrations	5	between sensor and zero point	17
Safety instructions	5	- the well is not empty	17
Safety instructions	6	Setting of level read-out	18
General	6	Setting of the mA output	19
Repair	6	Setting of relay outputs	20
Ex equipment	6	Selection of relay function for	
Product identification	6	relay 1 (and 2)	20
Mounting	7	Pump control with relay 1 and 2 ..	21
General	7	Level control with relay 1	22
Explosion potential areas	7	System alarm on relay 1	23
Mechanical mounting	7	Selection of relay function for	
Level transmitter	7	relay 2	24
Ultrasonic sensor	8	Level control with relay 2	25
Electrical mounting	9	System alarm on relay 2	26
Level transmitter	9	Start of the learning function ...	27
Ultrasonic sensor	10	First time activation	27
Cutting the cable	10	Activation of the	
Display and keyboard	11	learning function	28
General	11	Activation / deactivation	28
The display	12	Bar graph read-out	29
Symbols displayed during program-		Enhanced settings	30
ming	12	Active measuring range	30
Symbols displayed during normal		Response time	31
service	12	Measuring method	
The keyboard	13	(application)	32
Basic settings	13	mA output condition at	
Enhanced settings	13	system error	33
Get started	14	Calibration of the level	
Applying power to Shuttle®	14	measurement	34
- the well is empty... ..	14	Select factory settings	35
- the well is not empty... ..	14		

User and factory settings	36	Appendix	41
Factory settings	36	Technical specifications	41
Possible settings	37	<i>Shuttle®</i> Level Transmitter	41
Fault finding	38	<i>Shuttle®</i> Ultrasonic Sensor	41
General	38	Change of the supply voltage ..	42
Indications on system errors ...	38	Conversion from	
Normal read-out	38	115 V AC to 230 V AC	42
Too weak or missing echo	38	Conversion from	
System error	38	230 V AC to 115 V AC	42
Power failure	38	Considerations when mounting	
Fault finding table	39	the ultrasonic sensor	43
		General	43
		The spread of the ultrasonic signal	43
		Measuring along a wall or	
		other plane	44
		Measurement trough a	
		concrete deck	44
		Measurement in a tank/container	44
		Measurement through a pipe for	
		foam protection.	44
		Service menu	45

Introduction

Thank you for choosing a *Shuttle®* Ultrasonic Level Transmitter.

We have done whatever possible to make a level transmitter that can fulfill all your demands.

Shuttle® is suitable for all kinds of level measurements with ultrasound and can control and supervise levels in wells and tanks with all types of liquids - including aggressive and polluted media.

The level meter is both easy to install and to put into service, but read this manual first - then you will get the optimum from the *Shuttle®* ultrasonic level transmitter right from the beginning.

You can always contact your representative or the MJK Automation Hotline or for advice and guidance. Also, take a look at <http://www.mjk.dk>.

Shuttle® is registered trademark of MJK Automation A/S.

About this manual

Main sections

This manual is divided into the following four main sections:

- 1: Introduction
presentation of the *Shuttle®* and this manual
- 2: Mounting
information for performing mechanical and electrical mounting.
- 3: Basic settings
a look through the most common settings
- 4: Enhanced settings
a look through the settings necessary at certain applications of the *Shuttle®*.

Illustrations

All the *Shuttle®* display read-outs are illustrated in this manual. Some of the display segments will flash, and in this manual the display readouts with flashing segments are coloured white and the fixed segments are coloured black.



Example: Normal display readout - none of the segments are flashing.



Example: Missing echo - the bar on the right hand side is flashing.

Safety instructions

- 1: Read this manual carefully.
- 2: Be aware of the environment on the installation site. Wear necessary protective equipment and follow all current safety regulations.
- 3: *Shuttle®* can give out a start signal for dangerous machinery. Always ensure that eventually connected machinery and other equipment **are effectively being put out of service** by i.e. removal of main fuses, lock main- and/or security switches in off position before commencing setting, fault finding, service- and maintenance work etc.
- 4: There is a risk of lethal electrical shock from terminal 1 to 5 and L-N. Be careful not to touch these while *Shuttle®* is in service.

Repair

- 1: Repair of Ex approved equipment (ultrasonic transmitter) must only be made by MJK or by a service representative approved by MJK.

Ex equipment

- 1: All current local and national standards, regulations regarding installation and use of Ex approved equipment, certifications and safety instructions for Ex equipment, that have been used together with the installation of *Shuttle®* must be strictly observed.

Product identification

Check that the item(s) delivered corresponds to the ordered item(s). The item number is printed on a label that is stuck onto the packing. Below is shown the labelling for a delivery including a level transmitter and a ultrasonic sensor:



- | | |
|--------------------|------------------|
| ① Item number | ③ Serial number |
| ② Item description | ④ Supply voltage |

An identical marking can be found on the right hand side of the level transmitter cabinet:



Mounting

General

Shuttle® measures the level by sending an ultrasonic signal against the surface and measuring the delay time of the received echo.

Although *Shuttle®* is equipped with a very advanced system for eliminating measuring errors, the ultrasonic sensor must - as far as possible - be mounted so that the ultrasonic signal is not disturbed by liquid being pumped in or by mixers, ladders or other installations in the tank.

The liquid surface should also be calm and without waves from i.e. a mixer and possibly without foam that may muffle the ultrasonic echo too much.

Since the ultrasonic beam is extremely narrow (3 °), *Shuttle®* can be used for measurements in very narrow tanks or wells. This requires in return that the ultrasonic sensor is mounted so it points **absolutely vertical** against the surface - or else the ultrasonic echo will simply miss the sensor.

Explosion potential areas

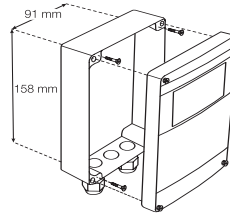
The ultrasonic sensor is Ex approved and can be mounted in Zone 2 without the need of a zener barrier.

The level transmitter (= the electronic box with display) must not be mounted in explosive hazardous areas.

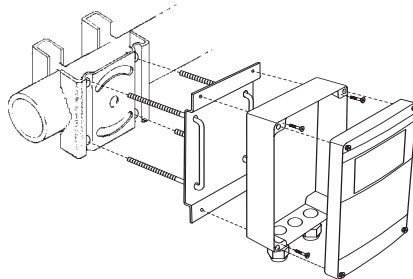
Mechanical mounting

Level transmitter

Shuttle® is in IP65 enclosure and can therefore be mounted outdoor directly on a wall, a railing or a banister with an MJK mounting plate 200240 and an MJK universal bracket 200205.



Shuttle® Ultrasonic Level Transmitter mounted directly on a wall.



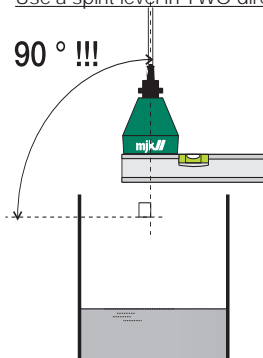
Shuttle® Level Transmitter mounted on the plant with MJK mounting plate 200240 and MJK universal bracket 200205.

Shuttle® must be mounted vertically in order to observe the IP65 standard.

Ultrasonic sensor

Two things are extremely important when mounting the ultrasonic transmitter: (See also Appendix C!)

- 1: It should be mounted firmly.
- 2: It should be mounted absolutely vertical.
Use a spirit level in TWO directions.



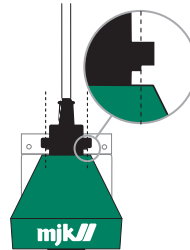
To ensure a reliable and precise level measurement it is of vital importance that the ultrasonic sensor points down absolutely vertical against the liquid surface.

Furthermore, the ultrasonic sensor should be mounted so the ultrasonic signal can pass without any obstructions from pipes, cables and other installations.

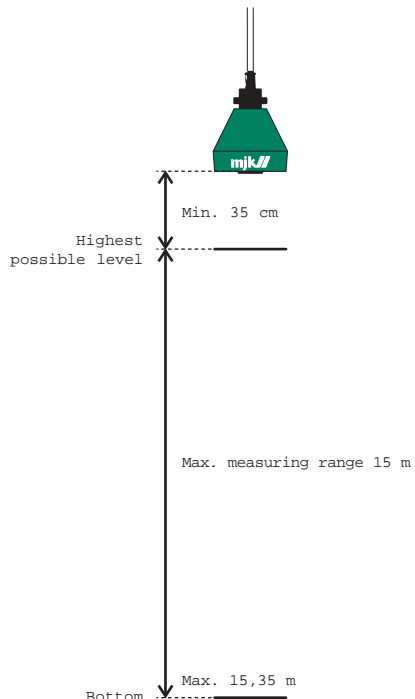


We deliver to types of sensor brackets that can be used in almost any installation. The bracket shown is a standard universal mounting bracket (200220).

The ultrasonic sensor is equipped with a nut for bracket mounting. Note the recess on the nut - it must be fitted safely in the bracket for firm and solid fixing to the bracket:



For the sake of an accurate measurement, the ultrasonic sensor should be mounted as close as possible to the highest level that can occur in the tank - however, always 35 cm above the highest possible level.



Electrical mounting

Level transmitter

Shuttle® must not be connected to the power supply before the ultrasonic sensor is mounted and connected correctly.

When the lid has been removed, the green plastic film with the menu symbols is tipped up to gain access to the terminals.



Shuttle® can be supplied with 10 - 30 V DC on terminal 10 and 12 or with 230 / 115 V AC on terminal L and N.

Current regulations for conductor and fuse dimensions should always be observed.

If Shuttle® is to be supplied from the mains, it should be checked if Shuttle® is intended for the present voltage.

If Shuttle® is delivered for 115 V AC supply, it will be indicated with a label below the leftmost terminal block as shown here:



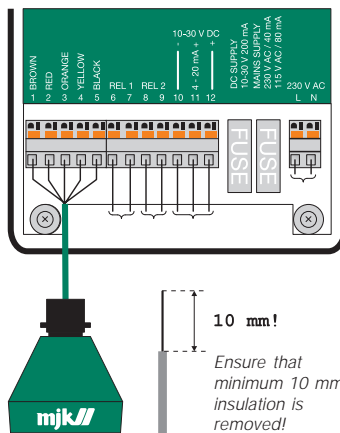
Shuttle® is intended for 230 V AC.



Shuttle® is intended for 115 V AC.

See Appendix B on how to change the mains supply voltage.

Mount the wires according to the terminal numbers on the reverse side of the plastic film:



Terminal: Designation:

1 - 5	Ultrasonic sensor
6 - 7	Relay output 1 (Max. 50 V, 1 A resistive load)
8 - 9	Relay output 2 (Max. 50 V, 1 A resistive load)
10 og 11	4-20 mA output (Max. 500 Ω load)
10 og 12	10 - 30 V DC supply
L	230 / 115 V AC live
N	230 / 115 V AC neutral

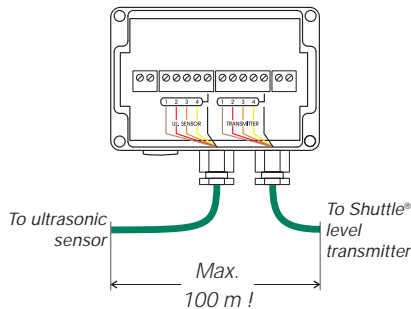
Ultrasonic sensor

The ultrasonic sensor is delivered as standard with 12 metres of cable. The ultrasonic sensor can be delivered with up to 100 metres of cable on order, but the existing cable can be extended to max. 100 metres.

The cable is a special low capacity cable, so extensions should always be made with the same type of cable.

On of the most common faults on a Shuttle® installation is poorly made and faulty cable connections.

It is therefore recommended to use MJK connection box 200590 if the sensor cable must be extended.



The ultrasonic sensor cable has 5 wires with both colour code and number:

Number:	Color:	Designation:
1	Brown	Ultrasonic pulse
2	Red	
3	Orange	
4	Yellow	Temperature compensation
5	Black	Shield ①

① This wire is connected to the cable shield.

The wires are mounted according to the terminal markings on the connection box PCB and on the Shuttle® respectively.

Cutting the cable

The cable is delivered with the wires stripped off as shown with the black wire (no. 5) soldered to the shield:



When the cable is cut, only 4 wires will appear:



When the cable has been cut, the shield should be mounted in terminal 5 instead of the black wire !

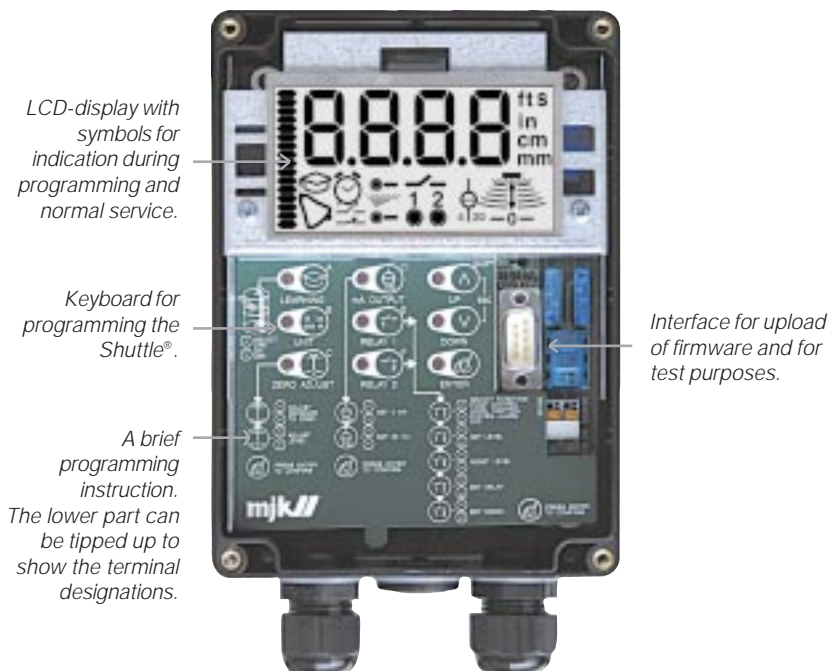
When the ultrasonic sensor is mounted and connected correctly, the Shuttle® can be connected to the power supply.

See the next section: 'Get started'.

Display and keyboard

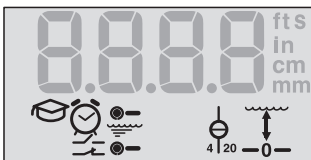
General

The keyboard are used only for the initial programming of the *Shuttle®*, and is therefore hidden behind the front lid. The keys are marked with symbols indicating their function. The same symbols are used throughout this manual under the explanation of the individual menus.

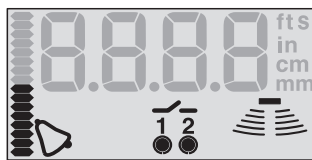


The display

The different display segments indicates the actual level, the state of the output relays etc. during normal service and indicates limit values, selection of measuring unit and other settings during programming.



The segments shown will be lit during programming of the Shuttle®.



The segments shown will be lit when Shuttle® are in normal service.

Symbols displayed during programming

8.8.8.8 Numerical read-out of limit values, delays and other numerical settings and selections. Is also used to show an initial letter code at start up of the extended settings.
See page 29 - 35.

**fts
in
cm
mm**

Displayed when selecting the desired measuring unit (see page 16) and when selecting time delays.



Start / activation of the learning function. See also page 27 - 28.



Flashes when setting the time delays.
See also page 21 - 23, 25 and 26.



Displayed when programming the output relays.
See also page 22 - 23 and 25 - 26.



Displayed when setting the start and stop levels for the output relays.
See also page 20 - 22 and 24 - 25.



Displayed when setting the zero point and span for the mA output.
See also page 19.



Displayed when setting the distance between sensor and zero point and setting of level read-out.
See also page 17 - 18.

Symbols displayed during normal service

8.8.8.8 Numerical read-out of the actual level.



Bar graph for indication of the signal level on the mA-output or for indication of the actual level.



Alarm symbol. The symbol is shown if a system error should occur on the Shuttle®.
See also page 23 and 26.



Indication of the status of the output relays. The round dot below the relay number will appear steady when the relay is activated and will appear flashing when the relay is about to be activated after a preset time delay.
See also page 21 - 23 and 25 - 26.



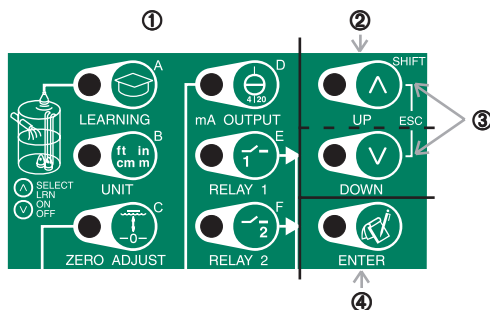
This group of symbols indicates the strength of the received ultrasonic echo. A good measuring signal are indicated by three sets of archs.
See also page 38.

The keyboard

From the *Shuttle®* keyboard the keys marked A - F (①) gives access to 2 x 6 menus divided in 6 basic settings and 6 enhanced settings.

There will be direct access to the menus for basic settings by pressing one the keys A to F, and acces to the menus for extended settings are given by holding down the SHIFT key (②) and pressing one of the keys A to F simultaneously.

When a menu has been selected, settings is made with the UP and DOWN keys and any selection are confirmed with the ENTER key (④) whereafter *Shuttle®* reverts to normal read-out. Any menu can be quitted without any changes of the setting by pressing the UP and DOWN keys simultaneously (ESCApe, ③).



Basic settings (see page 14 - 28)

- A (LEARNING)
Start and activation/deactivation of the learning function.
- B (UNIT)
Selection of measuring unit.
- C (ZERO ADJUST)
Setting of sensor distance and zero point.
- D (mA OUTPUT)
Setting of the mA output.
- E (RELAY 1)
Setting of the functions for relay output # 1.
- F (RELAY 2)
Setting of the functions for relay output # 2.

Enhanced settings (see page 29 - 35)

- Shift + A (bA - bAr graph)
Setting of the bar graph read-out.
- Shift + B (rA - rAnge)
Setting of the active measuring range.
- Shift + C (rE - rEsponse)
Setting of the response time for level changes.
- Shift + D (AP - APplication)
Setting of the control of the signal strength of the ultrasonic pulse.
- Shift + E (S. Err - System Error)
Setting of the condition of the mA output at system error.
- Shift + F (LE - LEvel)
Calibration of the level read-out.

Get started

Applying power to Shuttle®

When Shuttle® is connected to the power supply for the first time, the following is shown in the display:



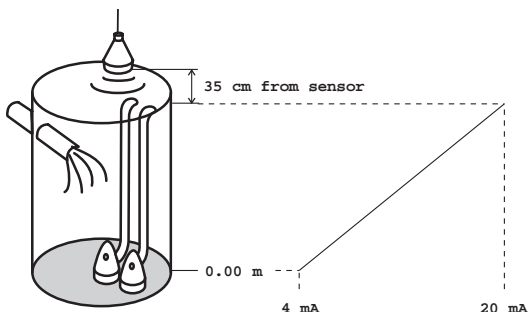
Press  once.

At the same moment Shuttle® registers an echo, the zero point is automatically adjusted to the level that is present in the tank or well in the same moment.

Furthermore, the mA output is set to 4 mA at the current zero point and 20 mA at a level corresponding to a distance of 35 cm from the ultrasonic sensor.

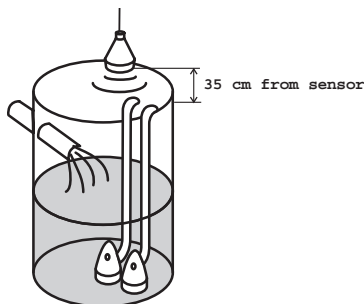
- the well is empty...

*Level read-out = distance
between sensor and bottom
- (minus) the distance
between sensor and
surface.*



- the well is not empty...

*The distance from the
sensor to the zero point or
the level read-out must be
set manually - see page 13.*



Shuttle® will now indicate the current level in the tank or well (0 m immediately after initial startup) and is now in service as a regular level meter, i.e. without the use of the relays and the analogue output for control / alarm.



See the next section for basic settings.

Basic settings

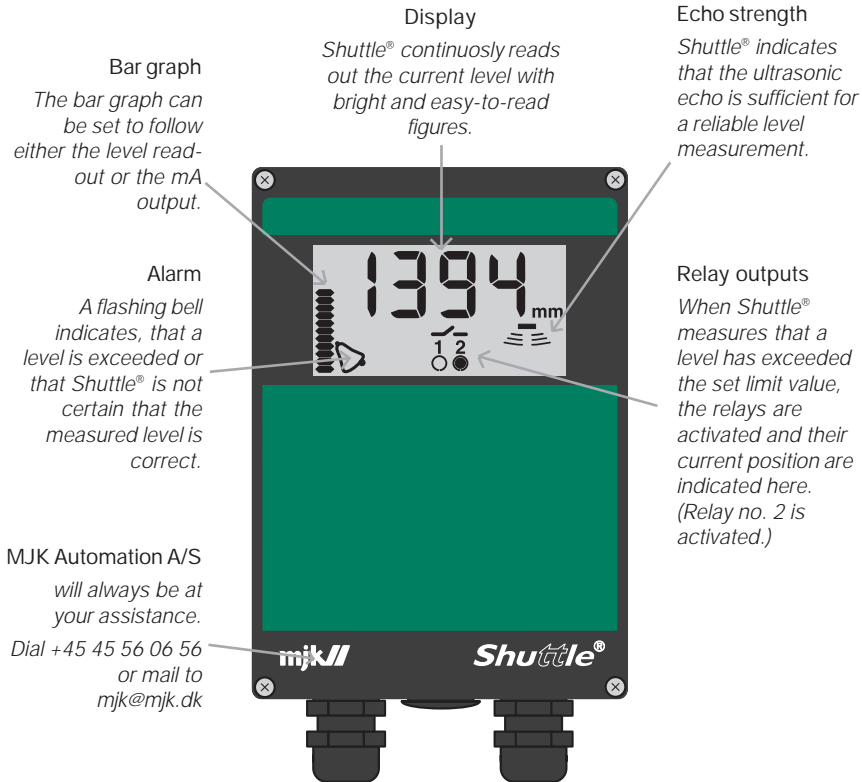
The automatic settings of zero point reading and mA output made by *Shuttle®* during initial startup may be adequate.

If changes of the zero point read-out and mA output setting should be necessary, and when *Shuttle®* is to be used as a pump controller or for level monitoring, an additional 5 settings should be made. These settings are described in detail on the following pages.

Advance in the order mentioned below:

- | | |
|--|-------------------|
| 1: Setting of measuring unit | See page 12 |
| 2: Setting of distance from sensor to zero point and
Setting of the level read-out: | See page 13 -14. |
| 3: Setting of the mA output: | See page 15. |
| 4: Setting of the relay limits: | See page 16. |
| 5: Start of the learning function: | See page 23 - 24. |

When the settings are made, *Shuttle®* is ready to be put into service.



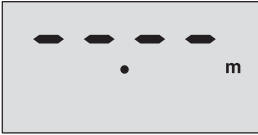
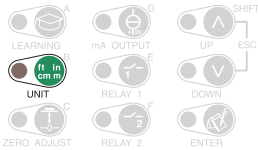
ft
in
cm
mm

Selection of measuring unit

If the measuring unit is changed, all other values in menus and settings will automatically be converted to the new measuring unit.

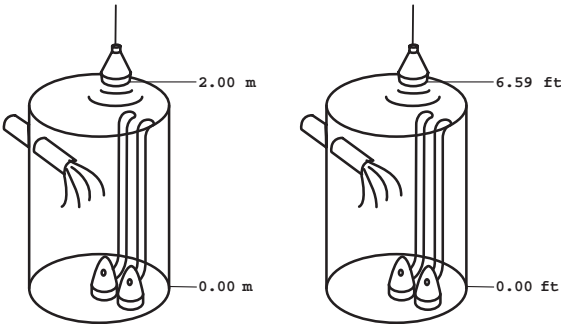
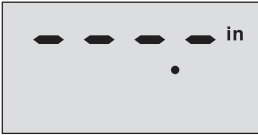
In this example the measuring unit is changed from metres to feet.

The settings will be rounded off automatically.



Select unit with the arrow keys.

The dot indicates the position of the decimal separator.



Note: 'mm' or 'in' cannot be selected if it could cause overrun in the display read-out.



Shuttle® reverts to normal read-out with the new measuring unit.

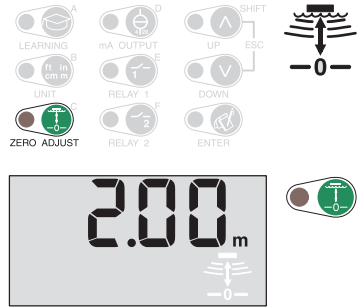


Setting of the distance between sensor and zero point - the well is not empty ...

The level read-out (zero point) can be set as required, which is convenient in case the well was not empty at initial startup.

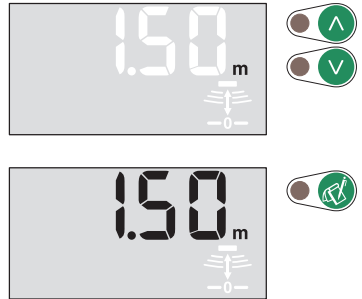
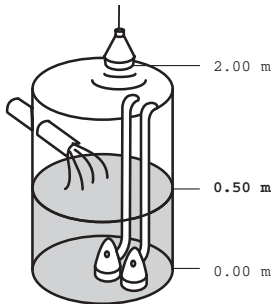
Note: The learning function settings will be erased and the relays will be deactivated if the zero point setting is changed.

In this example, the level read-out are changed to be 50 cm from the bottom of the well / tank.



Set the new zero point with the arrow keys.

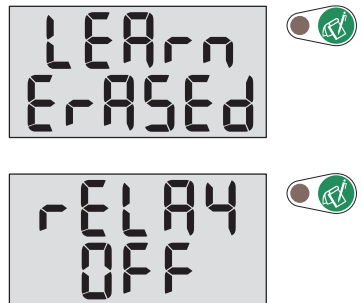
Shuttle® will now read out - 0.50 m when the well is empty.



If the learning function has been activated, Shuttle® will deactivate the learning function and erase the suspicious levels that was found last time the learning function was activated.

The learning function must therefore both be started and reactivated again.

If the relay outputs are configured for pump control, the relays will be deactivated, but their limit settings will not be erased. Also, delay settings and other settings will not be erased.



Shuttle® will now revert to normal level read-out.





Setting of level read-out

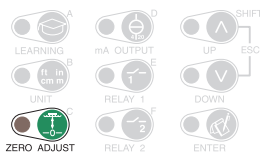
The well is not empty

With this function the level read-out can be increased or decreased on demand.

Note: The learning function settings will be erased and the relays will be deactivated if the zero point setting is changed.

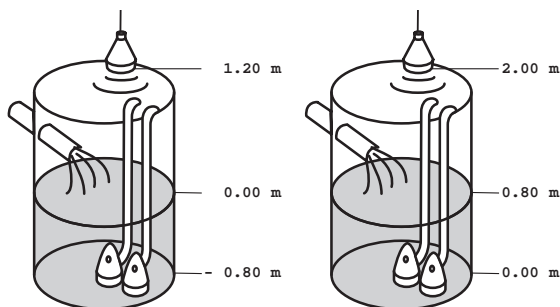


In this example, the actual level is 80 cm, but Shuttle® reads out 0 m.



Select the desired level readout with the arrow keys.

Shuttle® will now read out 0,00 m when the well is empty.



If the learning function has been activated, Shuttle® will deactivate the learning function and erase the suspicious levels that were found last time the learning function was activated.

If the relay outputs are configured for pump control, the relays will be deactivated, but their limit settings will not be erased.



Also, delay settings and other settings will not be erased.



Shuttle® will now revert to normal level read-out with a increased read-out value.

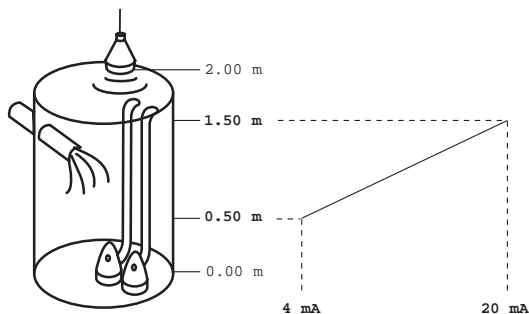
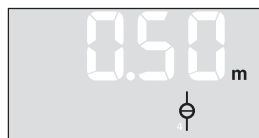
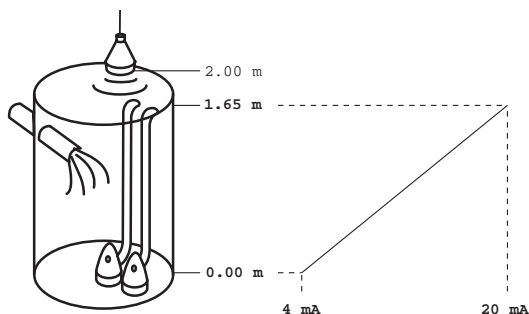
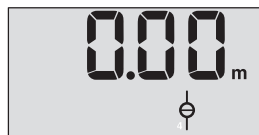
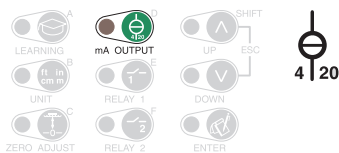


Setting of the mA output

When Shuttle® is connected to the power supply for the first time, the mA-output will be set to give off 4 mA at zero level and 20 mA at a level corresponding to 35 cm below the ultrasonic transmitter.

In this example the span of the ma output is changed from 0 - 1,65 m to 0,5 - 1,5 m. Changes made will not affect the relay settings.

Note: Both values can be set over the whole range thus making it possible to decrease the mA signal at rising levels and vice versa.



Shuttle® reverts to normal read-out.



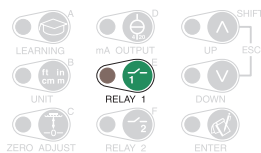


Setting of relay outputs

Selection of relay function for relay 1 (and 2)

Three functions are available:

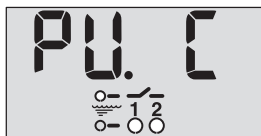
- pump control with alternation of two pumps
- level control
- system alarm



Select the desired function with the arrow keys.

Pump control:

Continue on the facing page.



Note: If pump control is selected, both relays are set in this menu and relay 2 will not be available in the menu for setting of relay 2.

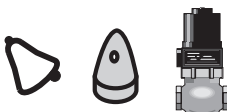
The relays can control both pumping in and pumping out, but both relays will have the same function. The function is selected automatically when relay 1 is set according to the start and stop levels. If the start level is set higher than the stop level, both relays will then be configured for pumping in. On the other hand, if the start level is set lower than the stop level, both relays will be configured for pumping in.

If it is later desired to change the setting, simply change the setting for relay 1 whereafter the start and stop setting for relay 2 will be switched automatically.

If the relays are configured for pump control, they will always be deactivated on system errors after 30 seconds independently of the selected time delay to prevent dry run of the pumps.

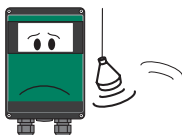
Level control:

Continue on page 18.



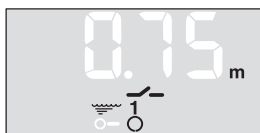
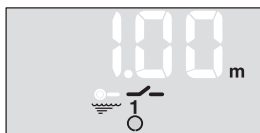
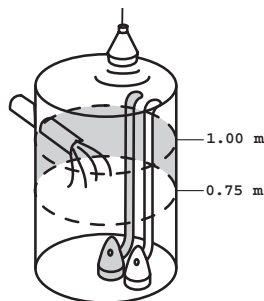
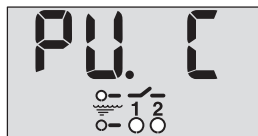
System alarm:

Continue on page 19.



Pump control with relay 1 and 2

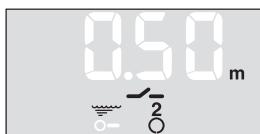
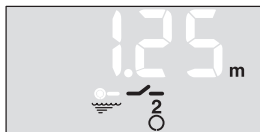
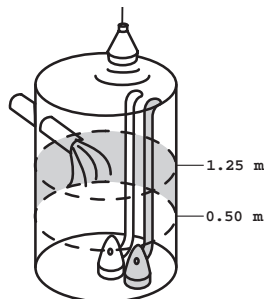
Start and stop level for pump no. 1 is set to 1,00 and 0,75 m accordingly.



Select the desired time delay for relay 1 with the arrow keys.



Start and stop level for pump no. 2 is set to 1,25 and 0,50 m accordingly.



Select the desired time delay for relay 2 with the arrow keys.



With these start and stop levels Shuttle® is now configured for pumping out and reverts to normal read-out.





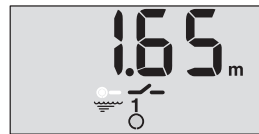
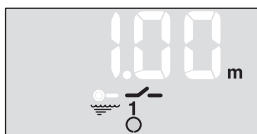
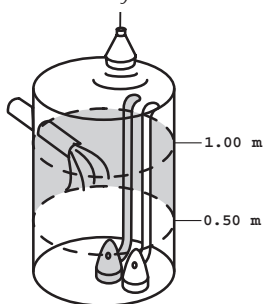
Level control with relay 1



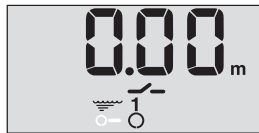
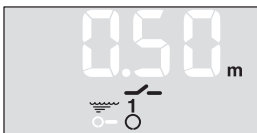
In this menu the level for activation (set) of relay 1 is changed from 1,65 to 1,00 m and deactivation (reset) of the relay output is changed from 0,00 to 0,50 m.



Select the desired activation (set) level for relay 1 with the arrow keys.



Select the desired deactivation (reset) level for relay 1 with the arrow keys.



Select the desired time delay.



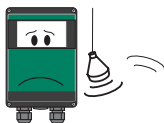
Select the reset position of the relay ('n.c' = normally closed, 'n.o' = normally open).



Shuttle® reverts to normal read-out.



System alarm on relay 1



In this menu the time delay is set for the activation of relay 1 when a system error occurs together with the reset position of the relay (normally open / normally closed):

Select the desired time delay.



Select the reset position of the relay ('n.c' = normally closed, 'n.o' = normally open).



Note: If 'n.c' is selected, Shuttle® will also give alarm in case of power failure.

Shuttle® reverts to normal read-out.

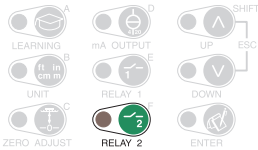




Selection of relay function for relay 2

Two functions are available:

- level control
- system alarm



Note: Both relays are already in use if pump control has been selected earlier. Therefore, relay 2 will not be available in this menu.



Select the desired function.

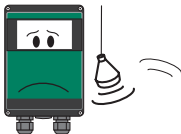
Level control:

Continue on the facing page.



System alarm:

Continue on page 22.

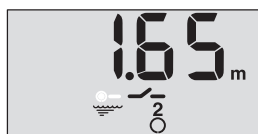
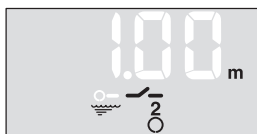
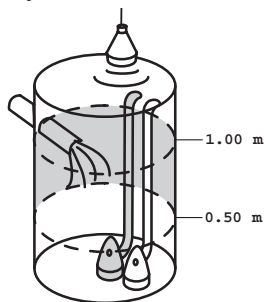


Level control with relay 2

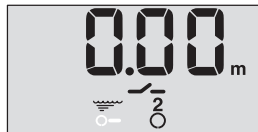


In this menu the level for activation (set) of relay 1 is changed from 1,65 to 1,00 m and deactivation (reset) of the relay output is changed from 0,00 to 0,50 m.

Select the desired activation (set) level with the arrow keys.



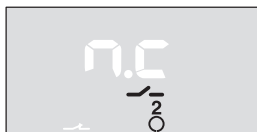
Select the desired deactivation (reset) level with the arrow keys.



Select the desired time delay.



Select the reset position of the relay ('n.c' = normally closed, 'n.o' = normally open).

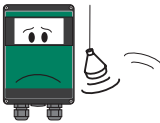


Shuttle® reverts to normal read-out.





System alarm on relay 2



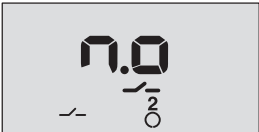
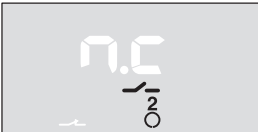
In this menu the time delay is set for the activation of relay 1 when a system error occurs together with the reset position of the relay (normally open / normally closed):



Select the desired time delay.



Select the reset position of the relay ('n.c' = normally closed, 'n.o' = normally open).



Note: If 'n.c' is selected, Shuttle® will also give alarm in case of power failure.



Shuttle® reverts to normal read-out.

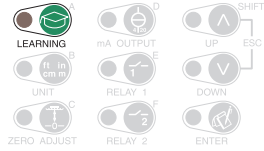


Start of the learning function

First time activation

With this function *Shuttle®* learns if there are any disturbances in the well or tank that could appear as a true echo. Disturbances can arrive from inlet pipes, the pump installation, a slanted bottom etc.

Shuttle® stores the levels where disturbances could occur thus practically eliminating the chance of measuring on a false echo.



Select the function with the arrow keys.

Note: Only this selection is available if the learning function settings have been erased earlier or the function has never been activated before.



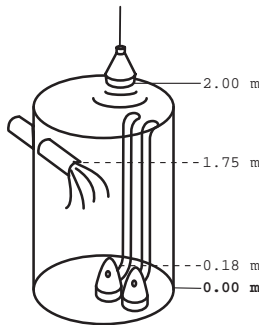
Shuttle® starts to investigate the tank / well for disturbances. The investigation is finished when all segments in the bar graph are lit.

Note: According to the number of disturbing elements, this process may take several minutes.



In this example, *Shuttle®* has found two false echos ① (the inlet) and ② (from the pump installation) and also the correct echo from the bottom of the well / tank.

Shuttle® will look for a maximum of 12 echos.



Select the level that is closest to the correct level +/- 15 cm (③).



②



③



Shuttle® has now learned at which levels there is a chance of disturbances and reverts to normal read-out.

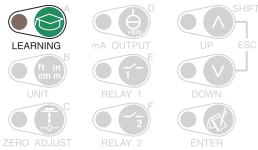




Activation of the learning function

Activation / deactivation

This function activates or deactivates the learning function.



Select with the arrow keys.



If OFF (deactivation) is selected, Shuttle® will still remember the levels of the false echos but will not take them into consideration.

If ON (activation) is selected, Shuttle® will take the false echo levels into consideration.



If LRN is selected, Shuttle® will start a new learning process.

Note: All levels found earlier will be erased.



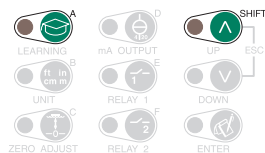
If OFF (or later ON) is selected, Shuttle® will revert to normal read-out.



Bar graph read-out

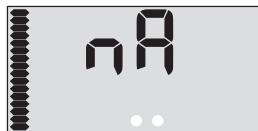
This function is used to select whether the bar graph should follow the analogue output or the level read-out.

Changes will not have influence on the relay settings.



The bargraph follows the analogue output.

Note: If the mA settings are inverted (the level reference at 4 mA is set higher than the level reference at 20 mA), the bar graph will increase when the level decreases and vice versa.



The bar graph follows the level read-out.



The bar graph is deactivated.



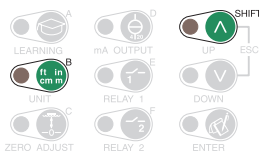
Shuttle® reverts to normal read-out.



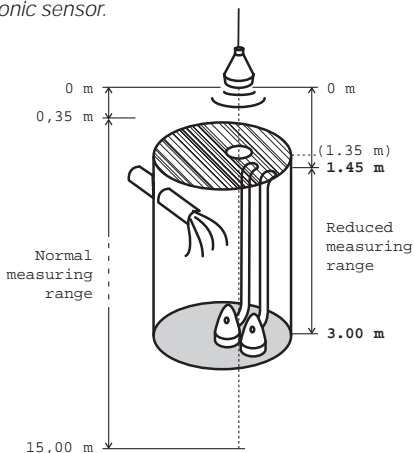
Active measuring range

Shuttle®'s measuring range is set to maximum (0,35 - 15 m measured from the sensor) from the factory. It may become necessary to decrease the active measuring range so it corresponds to the highest and lowest possible levels in the well /tank - especially if the ultrasonic sensor is mounted 1.35 m above a steel grating or an opening in a well cover.

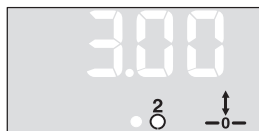
In this example Shuttle®'s active measuring range are decreased from 0,35 - 15 m to 1,45 - 3 m measured from the sensor - that is 3,00 m from the bottom to 10 cm below the grating or cover.



Set the start distance of the measuring range measured from the ultrasonic sensor.



Set the stop distance of the measuring range measured from the ultrasonic sensor.



Shuttle® reverts to normal read-out.

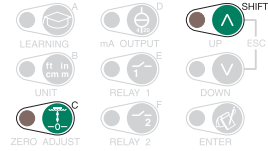


Response time

When the level changes, the display read-out will change accordingly with a certain delay.

The response time is set to 100 mm/s from the factory, which means that a level change of 100 mm will be shown in the display 1 second later.

When measuring on turbulent surfaces, it may become necessary to increase the response time in order to obtain a more stable level measurement and also relay function

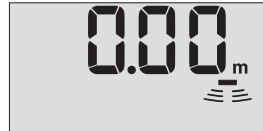


Select the desired response time with the arrow keys.

Note: Changing the response time will also change the response time for the mA output and the time for exceeding the set/reset levels.



Shuttle® reverts to normal read-out.

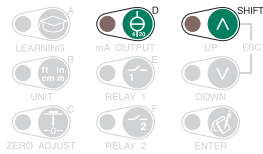


Measuring method (application)

Shuttle®'s great accuracy is partly obtained by controlling the strength of the ultrasonic pulse based on the strength of the received echo.

When performing level measurements on foaming surfaces, granulate, sludge containers etc., the received echo is generally so weak that it would be an advantage to let Shuttle® send out the ultrasonic pulses with full strength constantly.

To prevent that Shuttle® controls the strength of the transmitted ultrasonic pulse, the control function can be cancelled so that Shuttle® will transmit with full strength constantly.



Select measuring method with arrow keys.

If 'APP 1' is selected, the ultrasonic pulse will be controlled in accordance with the strength of the received echo.



If 'APP 2' is selected, Shuttle® will send with full strength constantly.



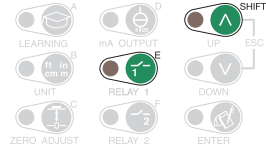
Shuttle® reverts to normal read-out.



mA output condition at system error

This function selects the condition of the mA-output if a system error should occur.

System errors are most often caused by a too weak or missing ultrasonic echo, but may also occur by failure of the ultrasonic sensor or failure in *Shuttle®*'s internal circuits.

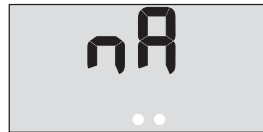


Select the desired condition with the arrow keys.

The mA output will be locked on the last known value when a system error occurs.



The ma output will give a fixed signal when a system error occurs.



Select the desired value (0,35 to 20,5 mA) of the fixed signal with the arrow keys.



Shuttle® reverts to normal read-out.

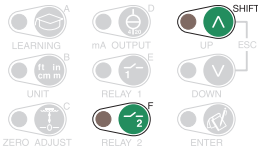


Calibration of the level measurement

If the distance of the ultrasonic sensor above the surface is known, it will be possible make a calibration of Shuttle®'s level read-out.

The calibration will only have influence on the level read-out - not on relay setpoints for pump control, alarms etc.

Note: For the sake of the built-in temperature compensation, it is important that the ultrasonic sensor has the same temperature as the surrounding air. This will take minimum 1 hour.



Select the desired correction with the arrow keys.



If the learning function has been activated, Shuttle® will deactivate the learning function and erase the suspicious levels that were found last time the learning function was activated.

The learning function must therefore both be started and reactivated again.



If the relay outputs are configured for pump control, the relays will be deactivated, but their limit settings will not be erased. Also, delay settings and other settings will not be erased.



Shuttle® reverts to normal read-out.

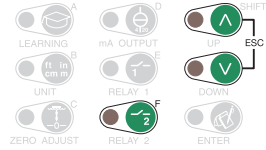


Select factory settings

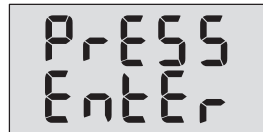
All settings - except fine adjustment of the level measurement - made after initial startup will be reset to factory settings with this function.

The zero point setting will also be adjusted to the immediate level in the well / tank. Furthermore, the mA output is set to 4 mA at the current zero point and 20 mA at a level corresponding to a distance of 35 cm from the ultrasonic sensor.

Note: The function will cause Shuttle® to start again precisely as it did when the supply power was turned on for the first time.



Select 'ON' with the arrow keys.



This is shown in the display until Shuttle® detects a valid echo again.



... whereafter Shuttle® returns to normal read-out.



Settings

User settings

Factory settings



Learning function: ☐ Off ☐ On



Measuring unit: ☐ m ☐ in ☐ ft ☐ mm ☐ cm



Sensor / zero point distance: _____

Level read-out setting: _____



mA output: 4 mA = _____

20 mA = _____

Relay outputs:

1 2

Off: ☐ ☐



Pump control: ☐

Level control: ☐ ☐

System alarm: ☐ ☐

Start level: _____

Stop level: _____

Relay delay: _____ sec.

NO/NC: ☐ (NC) ☐ (NC)

☒ Off

☒ m

± 0

± 0

Zero point

35 cm from sensor

1 2

☒ ☒

-

-

-

-

-

30 sec. 30 sec.

☒ (NC) ☒ (NC)

☒ mA output

From zero point to
35 cm from sensor

100 mm/s

☒ 1 (Fluid)

☒ Freeze

± 0

bA

Bar graph read-out: ☐ Off ☐ mA output ☐ Level read-out

rA

Active measuring range: _____

rE

Response time: _____ mm/s

AP

Measuring method: ☐ 1 (Fluid) ☐ 2 (Sludge and granulate)

S.Err

mA signal at system error: ☐ Freeze ☐ Fixed signal, _____ mA

LE

Calibration of level readout: _____

Possible settings

Learning function: On / Off
Measuring unit: m / in / ft / mm / cm

- ① Sensor / zero point distance: ± 60 m
Level read-out setting: ① ± 60 m
- ② mA output: ① $\pm 14,64$ m
② ± 15 m

Relay delay: 0 to 300 sec.
NO/NC: NO / NC

Bar graph read-out: Off / mA output / level read-out

Active measuring range: 0,1 to 15 m

Response time: 0,1 to 300 mm/s

Measuring method 1 (Fluid) / 2 (Sludge and granulate)

mA signal at Freeze / Fixed signal. (Fixed signal can be set from 3,5 to 20,5 mA)
system error:

Calibration of level readout: - 30 til 0,29 m

Fault finding

General

Almost all system errors are due to the echo from the ultrasonic sensor being either too weak or missing. This is normally caused by incorrect installation of the ultrasonic sensor, a faulty ultrasonic sensor or by faults on the cable between the ultrasonic sensor and the *Shuttle®* level meter. Other factors also have an influence on the ultrasonic level measurement. But always check first that the ultrasonic sensor is installed correctly and is working properly.

See also the fault finding table on the facing page.

Indications on system errors

First, *Shuttle®* will indicate that the echo is too weak or is missing. After 5 minutes, *Shuttle®* will indicate system error ('S.Err'), and if one of the relays is set to be activated on a system error, the relay will be activated after the preset delay time. At the same time the signal from the mA output will be either locked on the last known value or give out a preset signal value (3,5 - 20,5 mA).

If the cause disappears, *Shuttle®* will change back to normal read-out. At the same moment, the relay output set as alarm output will switch back to its normal position and the mA output will give out a normal signal.

Normal read-out

Shuttle® receives an echo that has sufficient strength for a safe and reliable level measurement.



Too weak or missing echo

The received echo is too weak for *Shuttle®* to perform a safe and reliable level measurement.



System error

If the echo is still too weak after 5 minutes, *Shuttle®* will go into system error mode and will eventually give an alarm to i.e. a SCADA system. At the same time, relays configured for pump control will be deactivated.



Power failure

If one of the relay outputs is set to NC (normally closed), an external alarm is immediately sent out at power failure.



Fault finding table

INDICATION	CHECK	CAUSE / REMEDY	
The display is not lit	Power supply	Wire mounting	Are minimum 10 mm of the insulation removed and firmly mounted?
		AC supply	Is correct live voltage present between terminals L and N? Is the right hand fuse (40 mA @ 230 V AC, 100 mA @ 115 V AC) intact? Exchange if necessary.
		DC supply	Is 10 - 30 V DC present between terminal 10 and 12 and is the polarity correct? Is the left hand fuse (200 mA) intact? Exchange if necessary.
Shuttle® indicates system error	Liquid surface	Measuring method (Shift + D)	Is the liquid surface foamy? Try changing the setting for measuring method from 'AP 1' to 'AP 2'.
	Ultrasonic sensor	Wire mounting	Is a minimum 10 mm of the insulation removed and wires firmly mounted? Are the wires connected to the correct terminals? See connection diagram.
		Cable extensions	Is there water in the connections? Are the extensions made correctly?
		Condition	Is the black part of the sensor discoloured or cracked? Discolouring indicates that the sensor is not suited for the environment on the installation site.
		Function	Is the sensor transmitting clicking sounds? If not, the sensor is faulty.
		Sensor mounting	Is the sensor mounted ABSOLUTELY VERTICAL? It is extremely important that the sensor is firmly mounted in a vertical position. See section 'Mechanical mounting of sensor'.
		Measuring distance	Is the sensor mounted so the measuring distance is less than 35 cm and more than 15 m ? The maximum / minimum measuring range must not be exceeded.

INDICATION	CHECK	CAUSE / REMEDY	
<i>Shuttle®</i> indicates system error constantly	<i>Shuttle®</i>	Setting	Is the setting of the active measuring range (Shift + B) correct? The active measuring range must not be set lower than the max. possible level.
Level read-out is not changing	Ultrasonic sensor	Sensor mounting	Is the sensor mounted ABSOLUTELY VERTICAL? It is extremely important that the sensor is firmly mounted in a vertical position. See section 'Mechanical mounting of sensor'.
		Installation site	Is there i.e. big fatty accumulations or other objects disturbing the ultrasonic signal?
		Setting	Has the learning function been activated? If the learning function have not been activated, <i>Shuttle®</i> may lock on a false echo.
Level read-out is wrong	Ultrasonic sensor	Sensor mounting	Is the sensor mounted ABSOLUTELY VERTICAL? It is extremely important that the sensor is firmly mounted in a vertical position. See section 'Mechanical mounting of sensor'.
		Cable	Is the sensor cable extended with a non-approved cable type and/or extended beyond 100 m?
		Installation site	Do the ultrasonic sensor have the same temperature as the surrounding air? Deviations will produce measuring errors.
	<i>Shuttle®</i>	Setting	<i>Shuttle®</i> 's level readout may need adjustment.
Level read-out is unstable	Ultrasonic sensor	Sensor mounting	Is the sensor mounted ABSOLUTELY VERTICAL? It is extremely important that the sensor is firmly mounted in a vertical position. See section 'Mechanical mounting of sensor'. Is the sensor mounted firmly? The sensor should be mounted on a suitable bracket.
		Installation site	Turbulence on the surface. Objects on the surface that disturbs the measurement. Strong winds can bend off the echo so it misses the ultrasonic sensor.
	<i>Shuttle®</i>	Setting	Response time (Shift + C) is set too high.

A Technical specifications

Shuttle® Level Transmitter

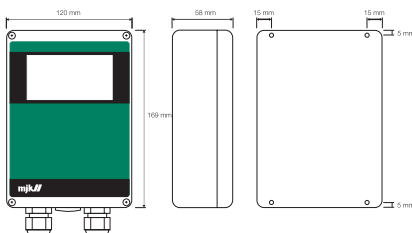
Measuring range:	0 - 15 m
Span:	From 0 - 10 cm to 0 - 15 m
Power suppl:	230 / 115 V AC
Consumption:	10 - 30 V DC
Temperature:	2 W approx.
Input:	- 20 ... + 60 °C
Accuracy:	From ultrasonic sensor
Outputs:	Better than $\pm 0,2 \%$
	Analogue: 4 - 20 mA, max. load 500 Ω .
	Digital: 2 x relays Max. 50 V 1 A resistive load.
Display:	LCD with 4 digits and symbols
Operation:	Function keys behind lid.
Enclosure:	IP65
CE approvals:	EN 50081-1, EN 50082-1

- ① The accuracy is stated for the selected measuring range with the sensor mounted 13.8 in above highest possible level and with subsequent calibration of level readout as explained on page 34 and when measuring on an even surface without foam build-up or other disturbing objects.

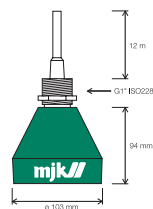
Shuttle® Ultrasonic Sensor

Measuring range:	15 m
Frequency:	30 kHz
Spread:	3 °
Deadband:	35 cm
Temperature:	- 20 ... + 60 °C
Materials:	PP (green) / POM (black)
Cable:	Shielded, insulated with oil resistant PVC, length 12 m, can be extended to max. 100 m.
Enclosure:	IP 68, water resistant, withstands submerging, max. 1 bar.
CE approvals:	EN 50081-1, EN 50082-1
Ex approvals:	EN 50021, Zone 2
	EEx nA II T3

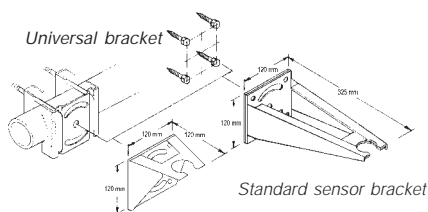
Dimensions



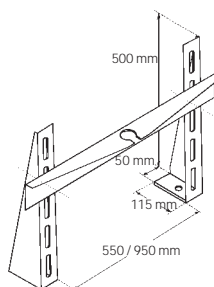
Shuttle® Level Transmitter



Shuttle® Ultrasonic Sensor



Short sensor bracket



Sensor bracket for channel or flume

B Change of the supply voltage

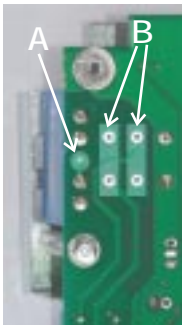
- 1: Remove the lid, detach the wires from the terminal blocks and remove the four screws that hold the electronics in the cabinet.



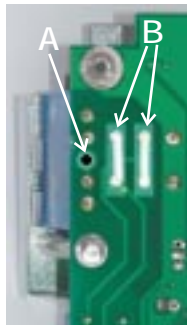
- 2: Take out the electronics and turn it around.

Look at the upper left corner and look if two soldering (LUS) (pos. B) are mounted and if the conducting branch (pos. A) is broken or not.

- no soldering (lus) is mounted (pos B) and the conducting branch (pos. A) is not broken: *Shuttle®* is intended for 230 V AC.
- two soldering (lus) are mounted (pos. B) and the conducting branch (pos. A) is broken: *Shuttle®* is intended for 115 V AC.



230 V AC



115 V AC

Conversion from 230 V AC to 115 V AC

Mount two soldering brackets between the soldering points (pos. B) and break the conducting branch or drill out the soldering point (pos A).

Turn around the electronics and exchange the left fuse to a 100 mA fuse.

Conversion from 115 V AC to 230 V AC

Remove the two soldering brackets between the soldering points (pos. B).

Close the conducting branch (pos A).

Turn around the electronics and exchange the right fuse to a 40 mA fuse.



*The **rightmost** fuse should be rated 40 mA @ 230 VAC or 100 mA @ 115 VAC.*

- 3: Mount the electronics in the cabinet, mount the wires in the terminal blocks and mount the lid.

C Considerations when mounting the ultrasonic sensor

General

The ultrasonic sensor is characterized by a very narrow spread of the ultrasonic signal (3 °), which makes it possible to use the ultrasonic sensor under very tight conditions, i.e. in narrow wells or tanks. 80 % of the ultrasonic signal is concentrated within this area, which will give a sufficient echo that is sufficient in the far most cases.

It is required, though, that the ultrasonic signal is not being muffled or disturbed by gratings, pipes, cables etc., and that the ultrasonic sensor is not mounted so the ultrasonic signal is sent too close to a tank wall or well wall.

The spread of the ultrasonic signal

The illustration to the left shows the spread of the ultrasonic sensor in conjunction with the measuring distance, i.e. the ultrasonic signal spread will be **23 in** at a measuring distance of **29 ft 9 in**.

It will appear, that increasing the measuring distance the distance from the center line to a **firm wall** should be increased accordingly.

MEASURING DISTANCE:	BEAM SPREAD:	MINIMUM DISTANCE TO FIRM WALL: (from center line)
1 m	15 cm	8 cm
2 m	20 cm	10 cm
3 m	26 cm	13 cm
4 m	31 cm	15 cm
5 m	36 cm	18 cm
6 m	41 cm	21 cm
7 m	47 cm	23 cm
8 m	52 cm	26 cm
9 m	57 cm	29 cm
10 m	62 cm	31 cm
11 m	68 cm	34 cm
12 m	73 cm	36 cm
13 m	78 cm	39 cm
14 m	83 cm	42 cm
15 m	89 cm	44 cm

Table 1: The ultrasonic signal spread along a firm wall and minimum distance to center line in conjunction to the measuring distance.

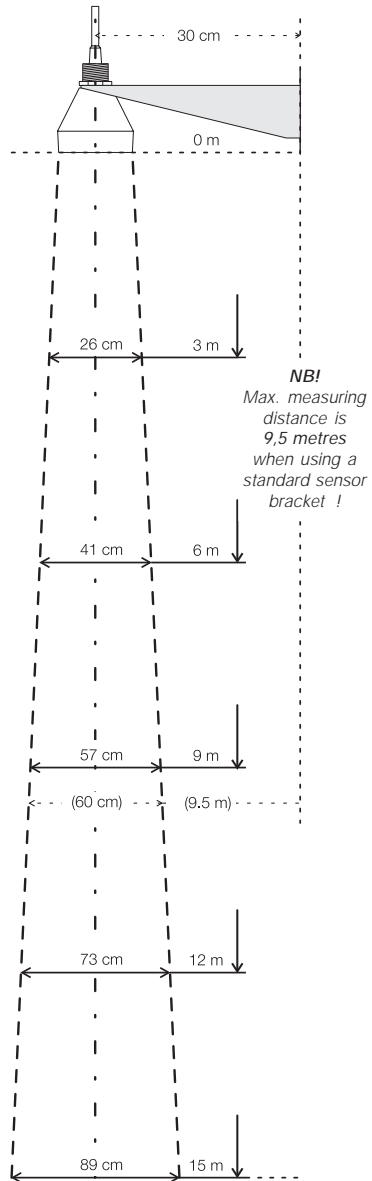


Figure 1: The signal spread in conjunction with the measurement distance. The spread value should be increased by 50 - 100 % if the surface is not firm!

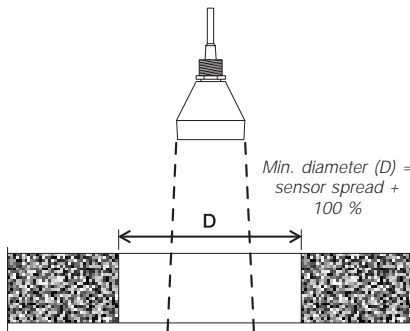
Measuring along a wall or other plane

The values in table 1 can be with no correction, if the ultrasonic signal is sent along a *smooth surface like a wall or plane without any projections, joints, butts etc.*

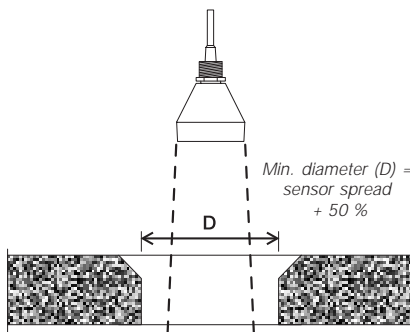
If the surface is not smooth or have projections from i.e. joints on prefab elements, the ultrasonic signal will be deadend too much, and for that reason *the values for minimum distance to wall in table 1 should be increased with 50 - 100 % !*

Measurement trough a concrete deck

When the ultrasonic sensor is measuring through a concrete deck, the dimension of the opening should be made as shown below: (See table 1 for the sensor spread.)



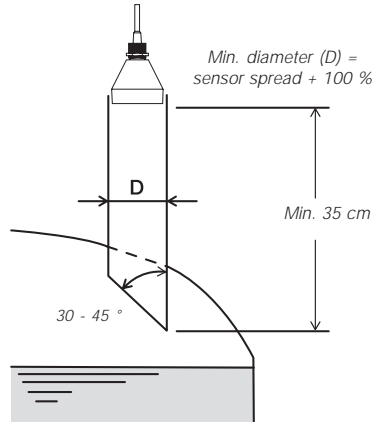
Measurement through a concrete deck with sharp edge.



Measurement through a concrete deck with 45 - 60 ° edge cutoff.

Measurement in a tank/container

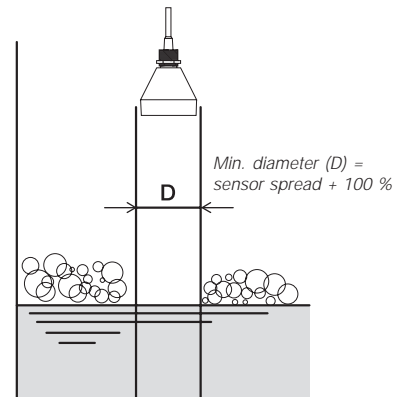
If the ultrasonic sensor is mounted for measurement of the level in a closed tank or container, it should measure through a pipe with a cutoff as shown below:



Measurement in a closed container or tank.

Measurement through a pipe for foam protection.

When measuring on liquids prone to build up foam on the surface, it can become necessary to measure through a pipe, since the build up of foam rarely will occur inside the pipe.



Measurement through a pipe for foam protection.

D Service menu

Shuttle® has a service menu that gives access to settings that normally should not be altered by the user and therefore are protected by a password.

The service menu includes:

- adjustment of the 4-20 mA output
- adjustment of the temperature compensation
- adjustment of the interval of the investigative measurement
- software and hardware identification
- changing of the service menu access code
- self test function

Refer to '*Shuttle®* Service Manual' for further information of the functions in the service menu.

Liability

MJK Automation A/S are liable to the common rules of Danish law on product liability, however, the liability is reduced to coverage of our public liability insurance of products. To the extent where nothing else follows in lines of invariable rules of law, we are not liable for loss of profits and working deficits or other indirect losses.

Changes

As our products are developed continuously, we reserve the right to make any alterations without prior notice.

